PICATINNY ARSENAL

TECHNICAL GROUP

CHEMICAL DEPARTMENT

TECHNICAL REPORT

SERIAL NO. 1293

DATE May 26, 1943

SUBJECT: STUDY PROPERTIES OF RDX COMPOSITION C2

FIRST AND FINAL REPORT

PAGE A

CLASSIFICATION CANCELLED
BY AUTHORITY OF O. C. M. NO. 30838
BY COL. I. A. CRUMP
DATE 1 AUGUST 1946

SYNOPSIS

The duPont Company has developed a new formula for the plastic explosive RDX Composition C which is designated as RDX Composition C2. It was requested that explosive and physical tests be made of Composition C and Composition C2 in order that a comparison of these two explosives might be made.

The results of the tests indicate that Composition C2 is slightly more sensitive to impact and more brisant than Composition C. There is no appreciable difference in sensitivity to initiation or heat between the two materials. The sound pressures measured in the Demolition Block Test indicate that both compositions consistently detonate with high order at -40°C, ordinary temperature and 76°C. when initiated by Engineer Corps blasting caps with PETN base charge. No significant difference between the two compositions is considered to have been shown in this test. The stability of Composition C2 as measured by the 100°C. and 120°C. Vacuum Stability Tests is less than that of Composition C, but the values obtained in these tests for Composition C2 are about the same as for Pentolite and Tetrytol. Although Composition C is non-volatile, Composition C2 has a definite but small volatility at 25°C.. Composition C2 is considerably more plastic than Composition C at both -20°C. and 25°C.; the plasticity at -20°C. of Composition C2 is approximately the same as that of Composition C at 25°C.

In general, Composition C2 compares favorably with Composition C in all respects except that of volatility. It appears that the more favorable plasticity of Composition C2 has been obtained at the expense of somewhat increased volatility.

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TECHNICAL GROUP
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RESEARCH DIVISION

(6) Study Properties of RDX Composition C2.

FIRST AND FINAL REPORT

(9) Rept. nr. 1 (Final)

INTRODUCTION:

1. The duPont Company has developed a new formula for the plastic explosive RDX Composition C (Ref. A) which is designated RDX Composition C2. It is claimed that the new composition is greatly superior to Composition C in power, sensitivity and plasticity. Therefore, it was requested that Composition C2 be subjected to tests, along with Composition C, to determine their essential explosive and physical characteristics in order that a comparison of the two explosives might be made. It is understood that the compositions of these two explosives are as follows:

	RDX Composition C	RDX Composition C2
Cyclonite, %	88.3	78.7
Plasticizer, %	11.7	-
MNT, %	-	2.70
DNT (oil), %	-	12.0
TNT, %	-	5.0
Wet nitrocellulose, pyroxylin, %	-	0.3
Wet nitrocellulose, pyro, %	-	0.3
Special solvent, %	-	1.0

OBJECT:

2. To subject RDX Composition C and RDX Composition C2 to tests to establish their relative physical and explosive characteristics.

RESULTS:

3. The results obtained in the various tests of Composition C and C2 are recorded in Tables I and II.

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a. Sensitivity.

The Drop Test value obtained for Composition C was 100+ cm. as compared to 90 cm. for Composition C2. In the Rifle Bullet Impact Test, Composition C was unaffected at both air temperature and -40°C., while Composition C2 gave one low order detonation at air temperature and produced a small amount of smoke at both temperatures. The sensitivity to heat, as indicated by the Ignition Temperature Test, was the same for both explosives, the value being 285°C. The sensitivity to initiation values obtained in the Sand Test were practically identical, 0.25 grams of mercury fulminate and 0.11 grams of tetryl being required for Composition C, and 0.25 grams of mercury fulminate and 0.10 grams of tetryl being required for Composition C2.

b. Brisance.

The brisance value of Composition C obtained in the Sand Test using the 1700 gram bomb was 44.5, whereas that for Composition C2 was 46.9. The strength of Composition C as shown by the TNT equivalent obtained in the Ballistic Mortar Test was 1.199 and that of Composition C2 was 1.270. In the Demolition Block Test the maximum variation in sound pressure obtained was 11 percent for both explosives when fired at 76°C. At ordinary temperature,the maximum variation in sound pressure was 6 percent for Composition C and 12 percent for Composition C2. When the explosives were fired at -40°C. the maximum variation for both explosives was 12 percent. Composition C produced 22 percent more sound pressure than did standard TNT blocks at 76°C. and Composition C2 at this temperature produced an increase of 8 percent. When fired at air temperature, Composition C produced 13 percent more and Composition C2 12 percent more sound pressure than did the standard TNT blocks under the same conditions. At -40°C., 7 percent more sound pressure was recorded for Composition C than for the Standard TNT and a 24 percent increase was obtained for Composition C2.

c. Stability.

In the 100°C. Vacuum Stability Test, 0.30 cc. of gas was formed with Composition C and 1.99 cc. with Composition C2. The values obtained in the 120°C. Vacuum Stability Test were 0.72 cc. for Composition C and 9.21 cc. for Composition C2. In the 100°C. Heat Test, Composition C lost 0.035 percent in weight in the first 48 hours of heating and showed no loss in the second 48 hours, whereas 1.84 percent in weight was lost by Composition C2 in the first 48 hours and 1.50 percent during the second 48 hours.

d. Physical Characteristics.

The density of Composition C is 1.49 and that of Composition C2 is 1.57. When exposed for 96 hours in the Hygroscopicity Test at 30°C., 90 percent R.H., an increase in weight of 0.23 percent was obtained with Composition C and 0.55 percent with Composition C2. In 120 hours at 25°C., 0.007 percent of RDX Composition C was volatilized, and 1.17 percent of RDX Composition C2. The plasticity, as measured by penetration with the penetrometer for Composition C was

1.3 mm. at -20°C. and 6.3 mm. at 25°C.; for Composition C2 at -20°C. the penetration was 5.3 mm. and 12.6 mm. at 25°C.

DISCUSSION OF RESULTS:

4. Since RDX Composition C did not detonate under the impact of a 2 Kg. wt. dropped 100 cm. in the Drop Test and RDX Composition C2 detonated when the weight was dropped 90 cm., it is indicated that Composition C2 is slightly more sensitive to impact than Composition C. These values, however, are sufficiently high so that both explosives can be considered satisfactory with respect to impact sensitivity. This comparative insensitivity is further indicated by the results of the Rifle Bullet Impact Test at -40°C. and at air temperature. No detonations occurred in this test with Composition C at either temperature, nor was any smoke or burning observed. Only one low order detonation was obtained with Composition C2 at ordinary temperature but a small amount of smoke was produced in several shots at both -40°C. and at air temperature. In actual use these explosives are packed and transported in cardboard boxes and hence they would not be subjected to as severe conditions as those of the Rifle Bullet Impact Test.

5. Both explosives produced smoke at 285°C. in the Ignition Temperature Test; since the ignition temperature of cyclonite is 270°C., it is shown that the substances added to cyclonite in these compositions do not render the resulting mixtures more sensitive to heat. The values for the sensitivity to initiation are substantially the same for Compositions C and C2. It should be noted that neither Composition C nor C2 could be initiated with mercury fulminate alone in the Sand Test, but required a tetryl booster. Previous work (Ref. B) showed that not all blasting caps were capable of initiating Composition C in the Demolition Block Test, but Hercules Blasting caps with PETN base charge were found to give consistently high order detonations. Numerous failures to detonate were obtained, however, when duPont blasting caps containing a tetryl base charge were used with Composition C. During the present investigation, the Hercules Blasting Caps containing PETN were used in the Demolition Block Test and high order detonations (see paragraph 6) were also consistently obtained with both Compositions C and C2 regardless of whether the temperature of the blocks was -40°C., air temperature, or 76°C. In the Ballistic Mortar Test the usual No. 8 blasting caps containing tetryl were used, and no difficulty was experienced in obtaining complete detonation. This is believed to be due to the fact that the explosive is confined in the Ballistic Mortar Test, whereas in the Demolition Block Test it is unconfined.

6. In the previous Demolition Block Tests (Ref. B) it was assumed for reasons presented that all detonations which produced 18 percent less sound pressure than the maximum obtained were of low order.

Since the sound pressure values obtained for Compositions C and C2 did not show a variation of more than 12 percent in the present tests (Table II), it is believed that complete detonation was obtained. Further, since the average values obtained were in all cases above those of the Standard TNT Demolition blocks, which certainly detonated with high order, it is believed that Compositions C and C2 consistently gave high order detonations. In the absence of a standard procedure for the interpretation of the results of the Demolition Block Test, the percent increase in sound pressure of the explosive over that of the Standard TNT blocks fired at the same time and at the same temperature was used for purposes of comparison. When this is done (Table II) it may be seen that at ordinary temperature there is practically no difference between Composition C (13 percent) and C2 (12 percent). At 76°C., however, the increase in sound pressure over the standard TNT blocks is 22 percent for Composition C, and 8 percent for Composition C2. It was pointed out (Ref. B) that the maximum error due to observation is 7 percent; weather conditions, the state of the terrain between the point of explosion and the sound level meter and other factors undoubtedly also effect the values obtained. Since all of the tests in this investigation were conducted within a space of four hours, during which the air temperature varied but slightly, and since the standards were always fired at the same time as the composition being tested, it appears that an actual increase in sound pressure over that obtained at ordinary temperature occurs when Composition C is fired at 76°C. On the other hand, at -40°C., the increase in sound pressure over the Standard TNT block is 7 percent for Composition C and 24 percent for Composition C2. Thus a trend is indicated, suggesting that Composition C produces more sound pressure as the temperature is increased, and that Composition C2 produces more sound pressure as the temperature is decreased. This effect may be related to the greater plasticity (see paragraph 9) of Composition C2 as compared to Composition C. The hardening of Composition C at -40°C. may have reduced its sensitivity to initiation to such an extent that the blasting cap was unable to cause detonation consistently at the maximum rate.

7. It appears that the only objection which might be raised to Composition C2 is in connection with its volatility which amounts to a loss in weight of 1.17 percent in 120 hours at 25°C. Composition C2 has a strong odor which is similar to nitrobenzene, while Composition C has no detectable odor and is substantially non-volatile at 25°C. If Composition C2 were subjected to storage for any appreciable length of time, its sensitivity might increase due to the increase in percent of cyclonite as the volatile constituent is lost.

8. The plasticity of Composition C2, as measured by the Penetrometer, using a cone was greater than that of Composition C at both -20°C. and 25°C. At -20°C., the penetration of Composition C2 was approximately the same as that of Composition C at 25°C. In making the Demolition Block Test a further indication of the greater plasticity of Composition C2 was found. At -40°C. it was possible to push

the blasting cap into the blocks of Composition C2, while with Composition C this was impossible; it was necessary to insert the blasting cap at ordinary temperature in Composition C and then cool to -40°C. Thus for demolition work under conditions of extreme cold Composition C2 appears to be more suitable than Composition C with respect to plasticity. The improved plasticity of Composition C2, however, is accompanied by an increased volatility. Both of these effects may be due to the DNT and MNT oils in Composition C2.

9. Although a relatively large volume of gas (9.21 cc.) is formed when Composition C2 was subjected to the 120°C. Vacuum Stability Test, satisfactory stability is indicated by the 100°C. Vacuum Stability Test value. Composition C showed a low value in both tests. It is possible that the volatile matter in Composition C2 is in part responsible for the larger gas volume obtained with this explosive. Since Composition C2 evolved no more gas in either the 100°C. or 120°C. Vacuum Stability Test than is commonly obtained with Pentolite and Tetrytol, it is believed that Composition C2 possesses acceptable stability characteristics.

CONCLUSIONS:

10. It is concluded that Composition C2 is substantially equivalent to Composition C with respect to explosive characteristics. It is further concluded that Composition C2 represents an improvement over Composition C with respect to plasticity at low temperatures, but is somewhat more volatile.

RECOMMENDATIONS:

11. It is recommended that RDX Composition C2 be considered acceptable as a demolition explosive.

EXPERIMENTAL PROCEDURE:

12. The Rifle Bullet Impact, Ballistic Mortar, Ignition Temperature, Vacuum Stability, Heat and Drop Tests were conducted according to procedures standard at this Arsenal, as also were the density, hygroscopicity, and volatility determinations. Since it was found impossible to press Composition C or C2 at 3000 pounds per square inch for the Sand Test, these explosives were hand pressed in the detonator caps, as also was the mercury fulminate. The tetryl was separately pressed at 3000 pounds per square inch. Otherwise, the Sand Tests were conducted according to standard procedure.

13. The Demolition Block Test was conducted as described in Ref. B. In the tests at -40°C., dry ice was used to cool the blocks to this temperature; they were then rapidly transferred to the barricaded inclosure

and fired. Similarly, an electric oven maintained at 76°C. was used to heat the blocks to this temperature. As in the previous tests (Ref. B) Compositions C and C2 were fired in their cardboard boxes, the weights of the blocks having first been adjusted to exactly 0.50 pound. Due to the comparative lack of cohesion of both explosives, the use of the cardboard boxes was necessary at 76°C.; at ordinary temperature and at -40°C., the boxes were also used in order that this condition might remain constant throughout the tests.

14. The plasticity of Compositions C and C2 was measured using the Penetrometer with a cone. The procedure used was similar to that described in Specification No. 3-106D for Black Paint. In the test the tip of the cone was placed level with the surface of the block of the explosive as received, and then allowed to penetrate it for exactly 5 seconds. The distance penetrated was then measured; the results reported were the average of ten determinations made at different locations on the blocks. The temperature was measured by means of a thermometer inserted in the block.

REFERENCES:

A. OO 471.86/844 (C); PA 471.86/1042.
B. Technical Report No. 1260.

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Table I

Explosive and Physical Characteristics of RDX Composition C and RDX Composition C2.

Test	RDX Composition C	RDX Composition C2
Rifle Bullet Impact Test:		
At -40°C.: No. of trials	6	6
High order detonations	0	0
Low order detonations	0	0
No detonations	6[a]	6[b]
At ordinary temperature:		
No of trials	5	5
High order detonations	0	0
Low order detonations	0	1
No detonations	5[a]	4[c]

[a] No smoke or burning.
[b] On two of these shots a small amount of blue smoke was observed.
[c] On three of these shots a small amount of blue smoke was observed.

Test	RDX Composition C	RDX Composition C2
Drop Test, 2 Kg. Wt., cm. fall	100/	90
Sand Tests, 1700 gm. Bomb:		
Sensitivity to initiation:		
grams $Hg(ONC)_2$	0.25	0.25
grams tetryl	0.11	0.10
Brisance, gm. sand crushed	44.5	46.9
Ballistic Mortar Test:		
TNT equivalent	1.199	1.270
Ignition Temperature Test:		
Minimum temperature to cause decomposition in 5 seconds, °C.	285[d]	285[d]

[d] Only smoke was produced, there being no flame or explosion.

Test	RDX Composition C	RDX Composition C2
100°C. Vacuum Stability Test:		
Cc. gas in 40 hrs.	0.30	1.99
120°C. Vacuum Stability Test:		
Cc. gas in 40 hrs.	0.72	9.21
Density at 25°C.	1.49	1.57
Hygroscopicity at 30°C.		
90% R.H., % gain in 96 hrs.	0.23	0.55

Table I (Cont'd)

Test	RDX Composition C	RDX Composition C2
Volatility at 25°C.:		
% loss in 120 hrs.	0.007	1.17
100°C. Heat Test:		
Loss in first 48 hrs., %	0.035	1.84
Loss in second 48 hrs., %	None	1.50
Explosion in 100 hrs.	None	None
Plasticity, penetration with penetrometer, mm.:		
At -20°C.	1.3	5.3
At 25°C.	6.3	12.6

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Table II

Demolition Block Test

Explosive	Temperature, °C.	Sound Pressure, Bars Average	Sound Pressure, Bars Maximum	Sound Pressure, Bars Minimum	Maximum Variation,%	Percent difference between explosive and Standard TNT at same time and temp.
Standard TNT	76	1390	1444	1363		
Composition C	76	1703	1716	1530	11	+22
Standard TNT	76	1252	1363	1215		
Composition C2	76	1358	1444	1287	11	+ 8
Standard TNT	12	1325	1363	1287		
Composition C	12	1494	1530	1444	6	+13
Standard TNT	10	1198	1215	1147		
Composition C2	10	1338	1444	1287	12	+12
Standard TNT	-40	1269	1287	1215		
Composition C	-40	1358	1444	1287	12	+ 7
Standard TNT	-40	1275	1287	1215		
Composition C2	-40	1579	1716	1530	12	+24